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Precision of Statistics Derived from Missouri Statewide Angler Surveys

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Abstract.—We assessed the validity of using statewide telephone survey data to develop estimates of total angler effort and effort by water category (e.g., ponds and streams) for individual water bodies, management regions, and north–south geographic regions. Angler hours and trips for individual reservoirs and put-and-take trout parks were found to vary by less than 30% for both estimates, but effort estimates for individual streams and five classes of small impoundments were highly variable and imprecise because of the low number of cooperators fishing these waters. We found that survey results from 40 cooperators and 195 cooperator trips were required to obtain estimates of angler hours and angler trips, respectively, such that the variation of those estimates would be less than 30% for at least 80% of the water bodies meeting that sample size. We recommend that statewide surveys be used to assess only effort for water bodies that receive statewide use, that is, for those that draw from a very large regional or statewide population.

Most state fisheries resource agencies have implemented some type of statewide survey (SWS) to collect information about their angling constituents. Such SWSs provide a more representative sample of the entire angling population than on-site survey regimes by incorporating all types of waters, all seasons of the year, entire water bodies rather than only areas that can be effectively covered by a clerk, both day and night fishing, and appropriate proportions of both boat and bank anglers (Weithman 1991). Information derived from SWSs can provide insights into the desires of anglers before policy decisions are made, thus enabling resource managers to develop more proactive policies.

Ideally, estimates obtained from survey data are both accurate, reflecting as closely as possible the true values, and precise, such that repeated estimates are as close to one another as possible. Whereas accuracy is often most closely related to sampling methods, precision is typically a function of sample size. The quality of information, however, is critical, particularly when survey results are reported at arbitrary spatial scales. It is not uncommon for SWS results to be used to produce estimates of success or angling effort for specific fisheries, counties, management districts, and management regions, as well as at the statewide level.

The purpose of our study was to evaluate the use of statewide longitudinal telephone surveys in Missouri to generate angler statistics that more commonly would be derived from on-site creel surveys. We determined the precision of estimates of annual angler effort for each water body. To determine the validity of using statewide angler data to calculate effort estimates for individual water bodies, we determined the smallest geographical area by which cooperator information could be grouped and still provide reasonable precision of the estimate.

Methods

A longitudinal statewide telephone survey of Missouri anglers was conducted in 2-year seg-

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ments in 1983–1984, 1985–1986, and 1987–1988 (see Weithman [1991] for a detailed description of the survey methods). Different cooperators were used for each of the 2-year segments (2,500 in 1983; 5,000 in 1985 and 1987). Anglers were contacted in January through April and asked to be participants in the study. Those who agreed to participate in the study were contacted several times in the next 2 years to obtain specific information about their angling activities since they had been last contacted. We evaluated statewide angler survey estimates of cooperator trip data from these surveys for only 1983, 1985, and 1987. We believe the first years of each of the three 2-year survey periods were more representative than the subsequent years, which were influenced by reduced cooperator participation and perhaps a lower rate of interest in this study. Weithman (1991) documented an additional 10% loss in cooperators the second year of the survey. The sample sizes we used for this paper were lower than originally reported by Weithman because of angler attrition throughout the year.

We concentrated on estimated angler trips (each day constituted one trip) and angler hours because they are the basis for other survey estimates and because their associated variances would influence the precision of the other estimates. Estimates of angler trips and angler hours and associated estimates of variation were calculated for each water body in each of the 3 years studied. We calculated a coefficient of variation (CV) by dividing the standard error of the estimate by the estimate itself and expressed this as a percentage. We believe this estimate of variation is useful to fisheries managers because two times the resulting values are similar to a confidence interval that is constructed around the estimate. After evaluating plots of CVs against cooperator hours, we chose a CV of 30% as a cutoff point for maximum acceptable variation (that is, the standard error of the estimate is 30% of the estimate itself). A similar natural break at approximately 30% was found by Mills and Howe (1992). Also, we felt that this precision level would allow sound resource management decisions without spending the large amounts of money it would take to increase precision.

Effort estimates and the CV for our estimates were calculated for each water body for each year. Also, effort estimates and the associated CV were calculated for each year for the following groups: large reservoirs and arms of large reservoirs (n = 37), put-and-take trout parks (10), privately owned ponds (ponds) (114), privately owned small impoundments (103), U.S. Forest Service (USFS) lakes (9), Missouri Department of Conservation small impoundments (67), small community impoundments (306), and streams (47). Privately owned waters were classified as ponds or small impoundments according to their surface area; ponds were defined as waters of 5 acres (2.02 ha) or less, while small impoundments were larger than 5 acres. Streams were grouped by watershed because we were unable to identify which individual stream reaches were fished by cooperators.

For six of these water categories, effort estimates and CVs were also calculated by 11 fish management regions and by two north–south geographic regions. Individual large reservoirs and put-and-take trout parks were not included in analyses at the management region and geographic region level because estimates for individual water bodies mostly met the CV cutoff, as reported below; moreover, inclusion of these groups in the statewide survey may not be necessary because on-site evaluations that collect angler information already exist for these areas. Finally, we also calculated effort estimates and CVs at the statewide level (i.e., aggregating across all management regions and geographic regions for each water category).

The purpose of combining angler effort data from each of six water body types within each fisheries management region was to boost the number of cooperators and visits and, ultimately, to test the assumption that this would adequately increase precision of the estimates. Estimates and their relative precision were calculated to determine the smallest geographical area that could be used to create acceptable effort estimates for each of these water categories.

We also plotted the CV for angler-hour estimates for 1983 against the number of cooperators that fished a water body for all water bodies and plotted the CV for angler-trip estimates against the number of trips that cooperators made to a water body, grouping over the three survey years. On the basis of these relationships, we calculated the minimum number of cooperators and trips that would be necessary to ensure that the CV for our effort estimates remained below 30% for at least 80% of the individual water bodies meeting that sample size. We choose 80% because this value would be appropriate for making decisions for field biologists. We verified the presumed linear relationship between the number of cooperator trips and the number of cooperators by plotting the data and calculating the correlation coefficient for this association, thus documenting that managers can use

TABLE 1.—Number of trips that cooperators made to each water category in each of the three survey years. Categories for which statewide survey estimates had coefficients of variation (100 · SE/mean) less than 30% in at least two of the three years at the individual water body level are indicated by asterisks.

Variable	1983	1985	1987
Total cooperators	2,004	4,707	4,551
Trips			
Reservoirs*	3,828	8,012	6,965
Trout parks*	998	1,786	1,691
Ponds	1,590	3,631	5,681
Small impoundments	572	975	2,001
U.S. Forest Service lakes	25	188	94
Missouri Department of Conservation impoundments	571	982	1,100
Community impoundments	845	2,613	2,524
Streams	1,977	4,341	4,508
Total	10,406	22,528	24,564

whichever estimate is more readily obtained from their data.

Results

The number of survey respondents varied from year to year and among water categories (Table 1). When each water body was evaluated individually, only 5%, 14%, and 12% met the 30% CV cutoff, in years 1983, 1985, and 1987, respectively. Among these were the 14 individual large reservoirs (arms pooled) and all 4 put-and-take trout parks. Angler hours and trips were then evaluated for the remaining six water categories after grouping to management region. The estimates of variation improved after this grouping, remaining below the 30% cutoff for ponds in most management regions and for a majority of streams but staying high for the other water categories.

Grouping water categories into north and south geographic regions further reduced the CV. In most cases, water category analyses for angler hours by geographic region resulted in low CVs for ponds, small privately owned impoundments, small impoundments owned by the Missouri Department of Conservation, small community impoundments, and streams. USFS lakes, however, because of their very low sample size, still had high CVs even after this grouping. Analyses for angler trips showed a similar stabilization when conducted by geographic region.

When a statewide analysis was conducted, combining across management and geographic regions, all water categories had CVs less than 30% for the three survey years, except for USFS lakes in 1983 and 1987.

Using the 1983 relationship between the CV and the number of cooperators and cooperator trips, we calculated that a minimum of 40 cooperators and 195 trips would be required to be confident (i.e., CVs less than 30%) in the angler-effort estimates for at least 80% of the water bodies meeting those sample sizes. As expected, the relationship between the number of cooperator trips and the number of participating cooperators is linear. Large reservoirs and trout parks met the 30% cutoff a majority of the time, whereas ponds never met this cutoff.

Discussion

The abundance and spatial distribution of a particular type of aquatic resource within a state, and its subsequent use by anglers, should be considered when designing the sampling strategy and analyzing statewide angler survey data. Grouping water categories by management regions can increase the number of cooperators and visits and hence lead to improved precision for estimates of angler effort, but this improvement is insufficient to overcome inadequate sampling intensity. In our case, this was true for almost all water categories. Grouping waters by large geographic regions may not even overcome the problem of inadequate response size. Again, in our case, grouping water categories by north–south geographic regions provided adequately precise effort estimates for most water categories, but not for the low-sample-size USFS lakes. Very few cooperators fished USFS lakes, probably because the lakes were located in remote areas with no major population center nearby.

Angler effort can be adequately estimated at the individual water body level from statewide surveys for water bodies that have statewide appeal and hence draw a large number of anglers. We found this to be the case particularly for large res-

ervoirs, community lakes, and streams that were located near large urban areas.

To meet the 30% CV cutoff for most water bodies, we found that at least 40 cooperators were required. The same number was found by Mills and Howe (1992), who, also using a 30% CV cutoff, evaluated angler effort for chinook salmon *Onchorynchus tshawytscha* harvest for individual fisheries. It is unlikely, however, that 40 potential cooperators will reside near enough to any one small water body to use it regularly and, moreover, that those cooperators will be selected for a statewide survey. The sample size that would be required to generate a sufficiently large number of cooperators or visits to attain estimates with low CVs at the individual water body level would make the generation of effort estimates for individual water bodies, in our opinion, highly impractical. We concur with the conclusions of Weithman (1991) that reasonable effort estimates can be generated from statewide survey data only for individual waters that appeal to anglers at the statewide level. Waters with less statewide appeal should be grouped at geographic scales large enough to provide precise estimates, which may even be at the statewide level.

Several solutions can be used to generate effort estimates on individual waters that do not provide a high appeal to anglers statewide. First, on-site surveys can be conducted to target those local anglers that most frequently fish those waters. Second, a combination of on-site and telephone surveys can be conducted. The on-site survey can gather harvest and effort data as well as gather names and addresses of anglers who can be contacted later to obtain additional information on opinions, attitudes, and economic data. Third, increasing the sample size of cooperators in a telephone survey should ensure getting a representative sample of anglers fishing individual water bodies. Finally, surveyers can stratify the area around the water body and target anglers within that area to interview via mail or by a telephone survey. Whatever survey technique is used, managers must be aware of the precision of the estimates to ensure that the data support sound resource decisions.

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